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Mast et al.

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(54) **FUEL DRAIN VALVE FOR A TURBINE ENGINE**

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F02C 7/232	(2006.01)
F02C 7/30	(2006.01)
F01D 25/00	(2006.01)
F02C 7/22	(2006.01)
F16K 31/60	(2006.01)

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CPC ***F02C 7/232*** (2013.01); ***F01D 25/002*** (2013.01); ***F02C 7/222*** (2013.01); ***F02C 7/30*** (2013.01); ***F16K 31/602*** (2013.01); *Y10T 137/86863* (2015.04)

(58) **Field of Classification Search**

CPC F02B 77/04; B08B 9/00; F01D 25/002; F01M 11/04; F01M 11/0408; F05B 2260/602; F23D 2209/30; F02C 7/22

USPC ..... 134/169 A, 625.44, 625.45; 60/39.53, 60/39.091, 39.094

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,352,112	A	11/1967	Chase	
3,721,265	A	3/1973	Hoffland	
5,385,014	A	1/1995	Rathbun	
5,441,080	A *	8/1995	Baumann	137/625.46
2001/0004828	A1 *	6/2001	Nakamoto	60/39.094

FOREIGN PATENT DOCUMENTS

DE 2120213 B 5/1972

(Continued)

OTHER PUBLICATIONS

European Search Report in related European Application No. 13172524.4, dated Dec. 13, 2013, 4 pages.

(Continued)

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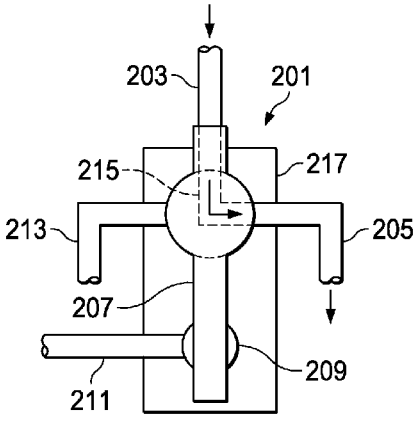
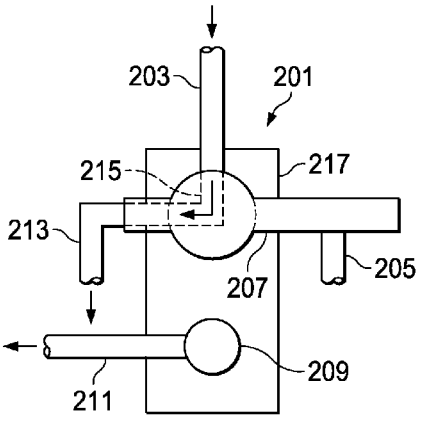
(57) **ABSTRACT**

A valve assembly for an engine, the valve assembly can include a housing; an in-flow port configured for connection with a drain line; a first out-flow port configured for connection with a fuel line; a second out-flow port configured for connection with a disposal line; and a passageway that is rotatable with a handle, the passageway being operable to redirect a flow of a fluid between the fuel line and the disposal line. The handle is configured to impede an attachment of the fluid source to a water wash connection when the passageway is in a position to direct the flow of the fluid from the drain line to the fuel line.

22 Claims, 3 Drawing Sheets





(56) **References Cited**

FOREIGN PATENT DOCUMENTS

DE	20107715	U1	8/2001
EP	0762029	A2	3/1997
EP	2052792	A2	4/2009
GB	111538		12/1917
GB	742485		12/1955

OTHER PUBLICATIONS

Communication in related European Application No. 13172524.4, dated Jan. 10, 2014, 6 pages.

Canadian Office Action in related Canadian Application No. 2,848,694, dated Mar. 12, 2015, 4 pages.

* cited by examiner

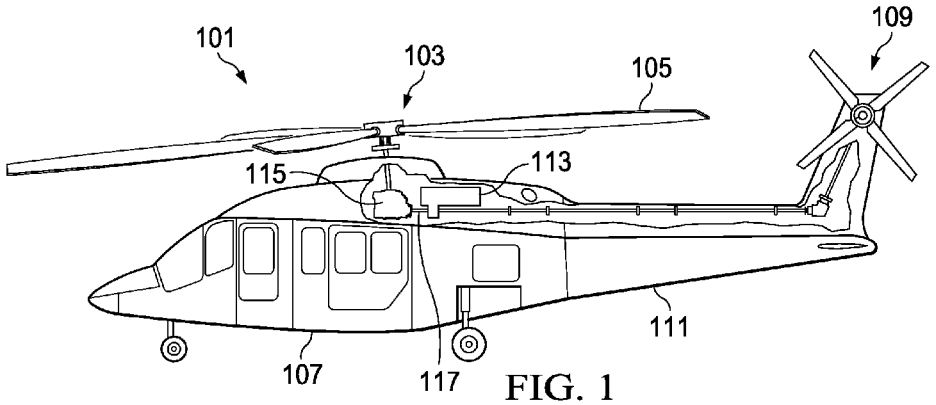

101
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FIG. 1

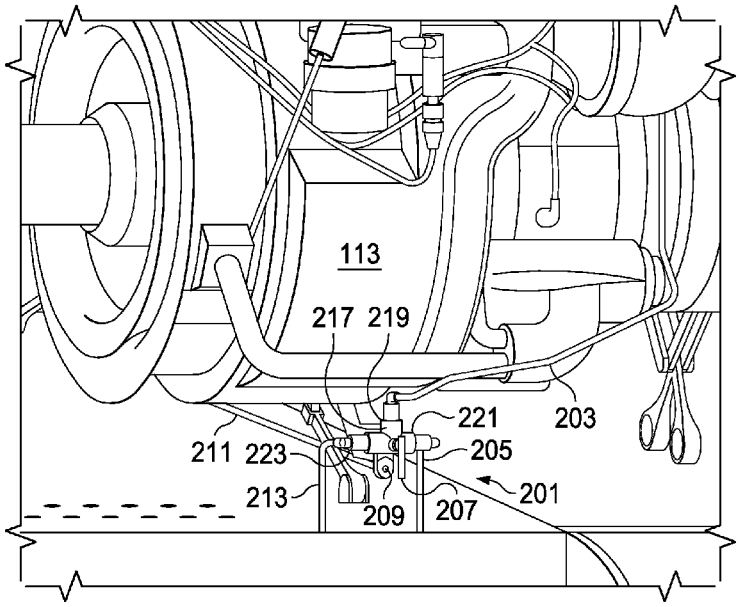
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FIG. 2

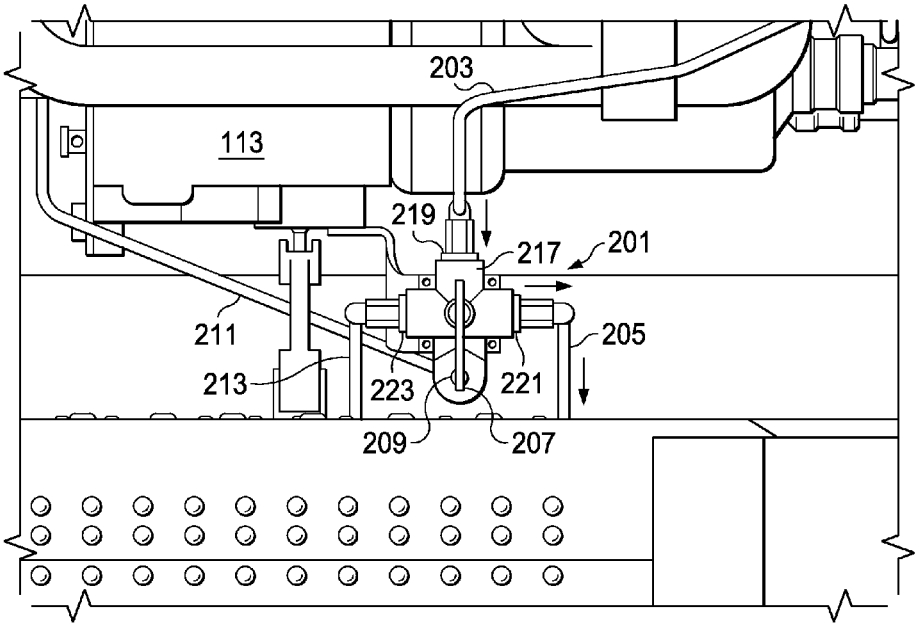
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FIG. 3

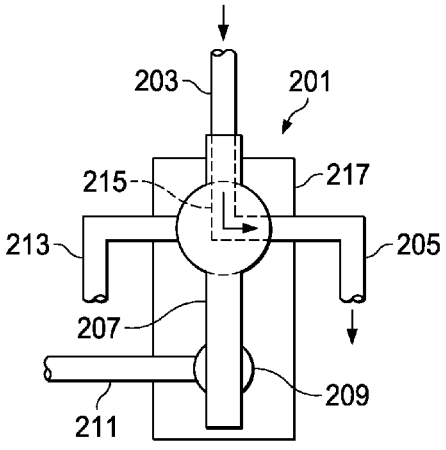
203
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FIG. 4

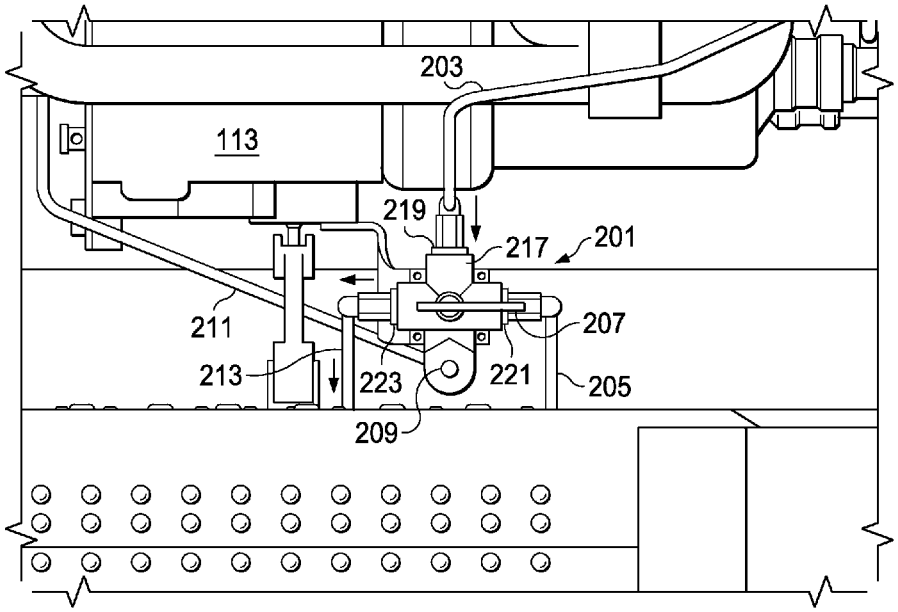
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FIG. 5

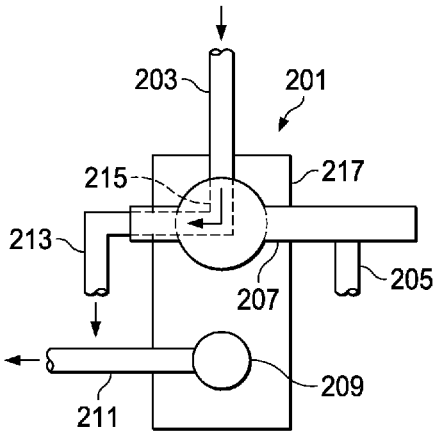
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FIG. 6

FUEL DRAIN VALVE FOR A TURBINE ENGINE

BACKGROUND

1. Technical Field

The present disclosure relates to a fuel drain valve for a turbine engine.

2. Description of Related Art

A turbine engine can require the draining of excess fuel that would otherwise accumulate in the fuel manifold unit during the shutdown of the turbine engine. In one conventional system, the excess fuel drains into a bottle which must be emptied by maintenance personnel. The bottle and associated plumbing adds weight and consumes valuable space in the engine compartment. In another conventional system, the excess fuel is drained onto the ground instead of into a bottle; however, draining excess fuel onto the ground is a non-environmental practice that is not always permitted.

Hence, there is a need for an improved apparatus for dealing with excess fuel that may otherwise accumulate in the fuel manifold during the shutdown of a turbine engine.

DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the apparatus of the present disclosure are set forth in the appended claims. However, the apparatus itself, as well as a preferred mode of use, and further objectives and advantages thereof, will best be understood by reference to the following detailed description when read in conjunction with the accompanying drawings, wherein:

FIG. **1** is a side view of a rotorcraft, according to one example embodiment;

FIG. **2** is a perspective view of an engine with a valve assembly, according to one example embodiment;

FIG. **3** is a side view of the valve assembly on the engine, with the valve assembly in the normal operation setting, according to one example embodiment;

FIG. **4** is a partially stylized side view of the valve assembly on the engine, with the valve assembly in the normal operation setting, according to one example embodiment;

FIG. **5** is a side view of the valve assembly on the engine, with the valve assembly in the water wash service setting, according to one example embodiment; and

FIG. **6** is a partially stylized side view of the valve assembly on the engine, with the valve assembly in the water wash service setting, according to one example embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Illustrative embodiments of the apparatus of the present disclosure are described below. In the interest of clarity, all features of an actual implementation may not be described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developer's specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.

In the specification, reference may be made to the spatial relationships between various components and to the spatial

orientation of various aspects of components as the devices are depicted in the attached drawings. However, as will be recognized by those skilled in the art after a complete reading of the present disclosure, the devices, members, apparatuses, etc. described herein may be positioned in any desired orientation. Thus, the use of terms such as "above," "below," "upper," "lower," or other like terms to describe a spatial relationship between various components or to describe the spatial orientation of aspects of such components should be understood to describe a relative relationship between the components or a spatial orientation of aspects of such components, respectively, as the device described herein may be oriented in any desired direction.

Referring now to FIG. **1** in the drawings, a rotorcraft **101** is illustrated. Rotorcraft **101** has a rotor system **103** with a plurality of rotor blades **105**. The pitch of each rotor blade **105** can be managed in order to selectively control direction, thrust, and lift of rotorcraft **101**. Rotorcraft **101** can further include a fuselage **107**, anti-torque system **109**, and an empennage **111**. Torque is supplied to rotor system **103** and anti-torque system **109** with at least one engine **113**. A main rotor gearbox **115** is operably associated with an engine main output driveshaft **117** and the main rotor mast.

Rotorcraft **101** is merely illustrative of the wide variety of aircraft, vehicles, and other objects that are particularly well suited to take advantage of the apparatus of the present disclosure. It should be appreciated that any object having a turbine engine can utilize the apparatus of the present disclosure.

Referring now also to FIG. **2**, engine **113** is illustrated in further detail. Engine **113** is a turbine engine that includes one or more portions that may benefit from the occasional washing in a maintenance procedure. For example, a compressor portion of engine **113** can include a plurality of compressor blades that can become contaminated over a period of operation. For example, dust and other particles can become deposited on the blades, which can decrease performance of engine **113**. As such, it can be especially desirable to wash the compressor blades so as to remove any undesired deposits. A water wash supply connection **209** is configured for attachment of an external fluid source for cleaning the compressor blades. It should be appreciated that the term "water wash" should be not be so narrowly construed to only include a water based fluid, but rather should be construed to include any appropriate fluid source sufficient for cleaning and flushing undesired deposits from within engine **113**. In one example embodiment, connection **209** can include a threaded portion configured for coupling to the external fluid source. Further, connection **209** can include one or more seals configured for preventing leakage of the cleaning fluid at the connection **209**. Connection **209** can be integral with valve assembly **201** such that a housing **217** forms a support for connection **209**. In another embodiment, connection **209** is supported separate from housing **217** of valve assembly **201**. It should be appreciated that one important feature includes the location of connection **209** in proximity of handle **207**, as discussed further herein.

In one example embodiment, water wash connection **209** includes an opening that forms a port to a fluid line **211** that is fluid communication with a water wash system (such as water wash nozzles) within engine **113**. An engine drain line **203** is configured to drain fluids from within engine **113**. The exact location of the location of the engine side portion of drain line **203** is implementation specific. Further, engine drain line **203** can include a plurality of drain lines that drain from a plurality of locations within engine **113**.

Still referring also to FIG. **2**, a valve assembly **201** can include housing **217** having an in-flow port **219**, a first out-flow port **221**, and a second out-flow port **223**. The in-flow port **219** provides fluid communication with drain line **203**. The first out-flow port **221** provides fluid communication with fuel line **205**. The second out-flow port **223** provides fluid communication with disposal line **213**. Valve assembly **201** is configured for selectively redirecting fluid draining from drain line **203** to either a fuel line **205** or to a disposal line **213** by selective rotation of an internal passageway **215**. The position of internal passageway **215** is selectively rotatable by a handle **207**. In one example embodiment, internal passageway **215** is "L" shaped so that the rotation thereof can redirect fluid from drain line **203** between disposal line **213** and fuel line **205**; however, it should be appreciated that the exact configuration of internal passageway **215** is implementation specific.

Disposal line **213** is configured as a fluid passageway for disposal fluids, as such; disposal line **213** is plumbed so that disposal fluids flow downstream from valve assembly **201** to a desired disposal area. In one example embodiment, disposal line **213** is plumbed to an engine deck where a scupper collects the disposal fluid and drains the disposal fluid out of the aircraft. In another embodiment, disposal line **213** is configured so that an external collection device can be connected thereto for collecting the disposal fluid.

Fuel line **205** is configured as a fluid passageway for engine fuel, as such; fuel line **205** is plumbed so that excess fuel from an engine shutdown flows to a fuel tank. As discussed further herein, excess fuel can be product of an engine shutdown; therefore, drain line **203** is plumbed to drain the excess fuel from engine **113** toward valve assembly **201** with fuel line **205** being downstream from valve assembly **201**.

Referring now also to FIGS. **3-6**, the operation of valve assembly **201** is illustrated in further detail. More specifically, valve assembly **201** is illustrated in the normal operation setting in FIGS. **3** and **4**, while valve assembly **201** is illustrated in the water wash service setting in FIGS. **5** and **6**. Referring first to FIGS. **3** and **4**, one important feature of valve assembly **201** is that handle **207** includes an extended portion that blocks and prevents a user (such ground maintenance personnel) from attaching an external fluid source to water wash connection **209** when drain line **203** is in fluid communication with fuel line **205**, which would cause water wash fluid to drain into a fuel tank. When handle **207** is oriented to prevent a connection of an external fluid source to water wash connection **209**, passageway **215** allows for fluid communication between drain line **203** and fuel line **205**. In such an orientation, handle **207** prevents the inadvertent contamination of the fuel system with the water wash fluid, but allows excess fuel from an engine shutdown to drain back into the fuel tank via fuel line **205**.

Referring now to FIGS. **5** and **6**, handle **207** is illustrated in the water wash service setting in which passageway **215** is oriented to provide fluid communication between drain line **203** and disposal line **213**. The position of handle **207** allows for the attachment of an external fluid source to water wash connection **209**. During the water wash service operation, the water wash fluid is sprayed into engine **113** and drains out of engine **113** via drain line **203**, then into valve assembly **201**, and then into disposal line **213**.

It should be appreciated that valve **201** can take on a wide variety of configurations. Further, it should be appreciated that the exact configuration of handle **207** is implementation specific. For example, handle **207** can be configured such that handle **207** must be rotated fully into the water wash service setting before water wash connection **209** is sufficiently exposed for a connection to an external fluid source.

The apparatus disclosed herein include one or more of the following advantages. The valve handle of the valve assembly is configured to prevent inadvertent contamination of the aircraft fuel system by not allowing an external fluid source to be connected while the valve passageway is oriented to provide fluid communication between the drain line and the fuel line. Further, the valve assembly allows for excess fluid generated from an engine shutdown to be drained to the aircraft fuel system, thereby preventing the need for a bottle or other fuel catching device. Further, the valve assembly eliminates any service action associated with emptying a fuel catching device. Further, the valve assembly prevents the draining of excess fuel onto a ground surface.

The particular embodiments disclosed herein are illustrative only, as the apparatus may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. Modifications, additions, or omissions may be made to the apparatus described herein without departing from the scope of the invention. The components of the apparatus may be integrated or separated. Moreover, the operations of the apparatus may be performed by more, fewer, or other components.

Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular embodiments disclosed above may be altered or modified and all such variations are considered within the scope and spirit of the disclosure. Accordingly, the protection sought herein is as set forth in the claims below.

To aid the Patent Office, and any readers of any patent issued on this application in interpreting the claims appended hereto, applicants wish to note that they do not intend any of the appended claims to invoke paragraph 6 of 35 U.S.C. §112 as it exists on the date of filing hereof unless the words "means for" or "step for" are explicitly used in the particular claim.

The invention claimed is:

1. A valve assembly for an engine, the valve assembly comprising:

a housing;

an in-flow port configured for connection with a drain line;

a first out-flow port configured for connection with a fuel line;

a second out-flow port configured for connection with a disposal line;

a passageway that is rotatable with a handle, the passageway being operable to redirect a flow of a fluid between the fuel line and the disposal line; and

a water wash connection;

wherein the handle impedes attachment of the fluid source to the water wash connection when the passageway is in a position to direct the flow of the fluid from the drain line to the fuel line.

2. The valve assembly according to claim **1**, further comprising:

wherein the handle allows for attachment of the fluid source to the water wash connection when the passageway is in a position to direct the flow of the fluid from the drain line to the disposal line.

3. The valve assembly according to claim **1**, wherein the water wash connection includes a threaded portion.

4. The valve assembly according to claim **1**, wherein the water wash connection is integral with the housing.

5. The valve assembly according to claim **1**, wherein the water wash connection is separate from the housing.

6. The valve assembly according to claim 1, wherein the passageway is L shaped.

7. The valve assembly according to claim 1, wherein the drain line is connected to the engine for draining the fluid from the engine.

8. The valve assembly according to claim 1, wherein the fluid comprises a fuel.

9. The valve assembly according to claim 1, wherein the fluid comprises a water wash fluid.

10. A turbine engine comprising:

a water wash system;

a valve assembly comprising:

an in-flow port configured for connection with a drain line;

a first out-flow port configured for connection with a fuel line;

a second out-flow port configured for connection with a disposal line;

a passageway that is rotatable with a handle, the passageway being operable to complete a fluid path between either the drain line and the fuel line or alternatively between the drain line and the disposal line; and

a connection for attaching a water wash fluid source.

11. The turbine engine according to claim 10, wherein the handle impedes attachment of the water wash fluid source to the connection when the passageway is in a position to complete a fluid path between the drain line and the fuel line.

12. The turbine engine according to claim 10, wherein the handle includes an elongated portion that impedes attachment of the water wash fluid source to the connection when the passageway is in a position to complete a fluid path between the drain line and the fuel line.

13. The turbine engine according to claim 10, wherein the connection includes a threaded portion.

14. The turbine engine according to claim 10, wherein the connection is integral with a housing of the valve assembly.

15. The turbine engine according to claim 10, wherein the connection is separate from a housing of the valve assembly.

16. The turbine engine according to claim 10, wherein the passageway is L shaped.

17. The turbine engine according to claim 10, wherein the fluid comprises a fuel.

18. The turbine engine according to claim 10, wherein the fluid comprises a water wash fluid.

19. The turbine engine according to claim 10, wherein the engine is an aircraft engine.

20. The turbine engine according to claim 19, wherein a portion of the fuel line downstream from the passageway is in fluid communication with a fuel tank of the aircraft.

21. The turbine engine according to claim 19, wherein a portion of the disposal line downstream from the passageway is in fluid communication with an engine deck of the aircraft.

22. The turbine engine according to claim 19, wherein a portion of the disposal line downstream from the passageway is configured for attachment to a disposal container.

* * * * *